

In the Claims

1. (original) A composition comprising vanadium and a support selected from the group consisting of: 1) amorphous silica-alumina; 2) a zeolite; 3) a material comprising meta-kaolin, alumina, and expanded perlite; 4) alumina; and 5) combinations thereof, wherein at least a portion of said vanadium has crystallite sizes of less than about 100 Å as determined by an analytical method such as X-Ray Diffraction.

2. (original) A composition in accordance with claim 1 wherein said vanadium is present in said composition, on an elemental vanadium basis, in an amount in the range of from about 0.5 to about 50 wt. percent, based on the total weight of said composition.

3. (original) A composition in accordance with claim 1 wherein said vanadium is present in said composition, on an elemental vanadium basis, in an amount in the range of from about 1 to about 20 wt. percent, based on the total weight of said composition.

4. (original) A composition in accordance with claim 1 wherein said vanadium is present in said composition, on an elemental vanadium basis, in an amount in the range of from about 1.5 to about 15 wt. percent, based on the total weight of said composition.

5. (original) A composition consisting essentially of vanadium and a support selected from the group consisting of: 1) amorphous silica-alumina; 2) a zeolite; 3) a material comprising meta-kaolin, alumina, and expanded perlite; 4) alumina; and 5) combinations thereof, wherein at least a portion of said vanadium has crystallite sizes of less than about 100 Å as determined by an analytical method such as X-Ray Diffraction.

6. (original) A composition consisting of vanadium and a support selected from the group consisting of: 1) amorphous silica-alumina; 2) a zeolite; 3) a material comprising meta-kaolin, alumina, and expanded perlite; 4) alumina; and 5) combinations thereof, wherein at

least a portion of said vanadium has crystallite sizes of less than about 100 Å as determined by an analytical method such as X-Ray Diffraction.

7. (original) A composition comprising vanadium and a support selected from the group consisting of: 1) amorphous silica-alumina; 2) a zeolite; 3) a material comprising meta-kaolin, alumina, and expanded perlite; 4) alumina; and 5) combinations thereof, heated in the presence of oxygen and a solvent to a calcination temperature; wherein said calcination temperature is sufficient to volatilize and remove substantially all of the solvent; and wherein said calcination temperature is below the temperature which would result in the conversion of greater than about 90 weight percent of the vanadium to vanadium-and-oxygen-containing crystallites greater than about 100Å in size.

8. (original) A composition in accordance with claim 7 wherein said solvent is an aqueous solution of oxalic acid.

9. (original) A composition in accordance with claim 7 wherein said composition is heated for a time period in the range of from about 0.1 to about 24 hours.

10. (original) A composition in accordance with claim 7 wherein said composition is heated for a time period in the range of from about 1 to about 4 hours.

11. (original) A composition in accordance with claim 7 wherein said vanadium is present in said composition, on elemental vanadium basis, in an amount in the range of from about 0.5 to about 50 wt. percent, based on the total weight of said composition.

12. (original) A composition in accordance with claim 7 wherein said vanadium is present in said composition, on elemental vanadium basis, in an amount in the range of from about 1.0 to about 20 wt. percent, based on the total weight of said composition.

13. (original) A composition in accordance with claim 7 wherein said vanadium is present in said composition, on elemental vanadium basis, in an amount in the range of from about 1.5 to about 15 wt. percent, based on the total weight of said composition.

14. (original) A composition in accordance with claim 7 wherein said calcination temperature is below about 400°C.

15. (original) A composition in accordance with claim 7 wherein said calcination temperature is above about 125°C and wherein said calcination temperature is below about 375°C.

16. (original) A composition in accordance with claim 7 wherein said calcination temperature is above about 150°C and wherein said calcination temperature is below about 350°C.

17. (withdrawn) A composition prepared by the method of:

a) incorporating a vanadium compound onto, into, or onto and into a support selected from the group consisting of: 1) amorphous silica-alumina; 2) a zeolite; 3) a material comprising meta-kaolin, alumina, and expanded perlite; 4) alumina; and 5) combinations thereof, in the presence of an oxidizing agent and a solvent, to thereby form a vanadium incorporated support; and

b) calcining said vanadium incorporated support at a calcination temperature; wherein said calcination temperature is sufficient to volatilize and remove substantially all of the solvent; and wherein said calcination temperature is below the temperature which would result in the conversion of greater than about 90 weight percent of the vanadium to vanadium-and-oxygen-containing crystallites greater than about 100 Å in size, to thereby form said composition.

18. (withdrawn) A composition in accordance with claim 17 wherein said solvent is an aqueous solution of oxalic acid.

19. (withdrawn) A composition in accordance with claim 17 wherein said vanadium incorporated support is calcined for a time period in the range of from about 0.1 to about 24 hours.

20. (withdrawn) A composition in accordance with claim 17 wherein said vanadium is present in said composition, on elemental vanadium basis, in an amount in the range of from about 0.5 to about 50 wt. percent, based on a total weight of said composition.

21. (withdrawn) A composition in accordance with claim 17 wherein said vanadium is present in said composition, on elemental vanadium basis, in an amount in the range of from about 1.0 to about 20 wt. percent, based on a total weight of said composition.

22. (withdrawn) A composition in accordance with claim 17 wherein said vanadium is present in said composition, on elemental vanadium basis, in an amount in the range of from about 1.5 to about 15 wt. percent, based on a total weight of said composition.

23. (withdrawn) A composition in accordance with claim 17 wherein said oxidizing agent is hydrogen peroxide.

24. (withdrawn) A composition in accordance with claim 17 wherein said vanadium compound is selected from the group consisting of: 1) ammonium metavanadate, 2) an alkali metavanadate of the formula MVO_3 , wherein M can be an alkali metal selected from Group IA, and combinations thereof; and 3) combinations of any two or more thereof.

25. (withdrawn) A composition in accordance with claim 17 wherein said support comprises alumina, meta-kaolin, and expanded perlite; and wherein said support is prepared by the method of:

1) adding said expanded perlite to a mixture of said alumina and water to thereby form a second mixture;

2) adding meta-kaolin to said second mixture to thereby form a third mixture;

3) adding a dispersant to said third mixture to thereby form a fourth mixture; and

4) calcining said fourth mixture to thereby form said support.

26. (withdrawn) A composition in accordance with claim 25 wherein said calcining of step 4) comprises heating said fourth mixture to a temperature in the range of from about 100°C to about 200°C for a first time period in the range of from about 0.5 hour to about 2 hours; and subsequently heating said fourth mixture to a temperature in the range of from about 500°C to about 750°C for a second time period in the range of from about 0.5 hour to about 2 hours.

27. (withdrawn) A method comprising;

a) incorporating a vanadium compound onto, into, or onto and into a support selected from the group consisting of: amorphous silica-alumina, a zeolite, a material comprising meta-kaolin, alumina, and expanded perlite, and combinations thereof, in the presence of an oxidizing agent and a solvent, to thereby form a vanadium incorporated support; and

b) calcining said vanadium incorporated support at a calcination temperature; wherein said calcination temperature is sufficient to volatilize and remove substantially all of the solvent; and wherein said calcination temperature is below the temperature which would result in the conversion of greater than about 90 weight percent of the vanadium to vanadium-and-oxygen-containing crystallites greater than about 100 Å in size, to thereby form said composition.

28. (withdrawn) A method in accordance with claim 27 wherein said solvent is an aqueous solution of oxalic acid.

29. (withdrawn) A method in accordance with claim 27 wherein said vanadium incorporated support is calcined for a time period in the range of from about 0.1 to about 24 hours.

30. (withdrawn) A method in accordance with claim 27 wherein said vanadium is present in said composition, on elemental vanadium basis, in an amount in the range of from about 0.5 to about 50 wt. percent, based on the total weight of said composition.

31. (withdrawn) A method in accordance with claim 27 wherein said vanadium is present in said composition, on elemental vanadium basis, in an amount in the range of from about 1.0 to about 20 wt. percent, based on the total weight of said composition.

32. (withdrawn) A method in accordance with claim 27 wherein said vanadium is present in said composition, on elemental vanadium basis, in an amount in the range of from about 1.5 to about 15 wt. percent, based on the total weight of said composition.

33. (withdrawn) A method in accordance with claim 27 wherein said oxidizing agent is hydrogen peroxide.

34. (withdrawn) A method in accordance with claim 27 wherein said vanadium compound is selected from the group consisting of: 1) ammonium metavanadate, 2) an alkali metavanadate of the formula MVO_3 , wherein M can be an alkali metal selected from Group IA, and combinations thereof; and 3) combinations of any two or more thereof.

35. (withdrawn) A process comprising:

a) contacting, in a contacting zone, a gaseous feed stream comprising a heavy metal and oxygen with the composition of claim 1; and

b) withdrawing a gaseous product stream from said contacting zone.

36. (withdrawn) A process as recited in claim 35 wherein said gaseous product stream contains less heavy metal than said gaseous feed stream.

37. (withdrawn) A process as recited in claim 35 wherein said gaseous feed stream further comprises a compound selected from the group consisting of sulfur oxides, CO₂, water, nitrogen oxides, HCl, and combinations of any two or more thereof.

38. (withdrawn) A process as recited in claim 35 wherein said gaseous feed stream is a combustion gas.

39. (withdrawn) A process as recited in claim 35 wherein said gaseous feed stream is a stack gas derived from the combustion of coal.

40. (withdrawn) A process as recited in claim 35 wherein said contacting of step a) is carried out at a temperature in the range of from about 100 to about 325 °C.

41. (withdrawn) A process as recited in claim 35 wherein said contacting of step a) is carried out at a temperature in the range of from about 125 to about 275 °C.

42. (withdrawn) A process as recited in claim 35 wherein said contacting of step a) is carried out at a temperature in the range of from about 150 to about 225 °C.

43. (withdrawn) A process as recited in claim 35 wherein said heavy metal comprises a metal selected from the group consisting of arsenic, beryllium, lead, cadmium, chromium, nickel, zinc, mercury, barium, and combinations of any two or more thereof.

44. (withdrawn) A process as recited in claim 43 wherein said heavy metal is mercury.

45. (withdrawn) A process as recited in claim 44 wherein said composition converts at least a portion of said mercury in said gaseous feed stream from a zero oxidation state to a +1 or a +2 oxidation state.

46. (withdrawn) A process as recited in claim 44 wherein said mercury is present in said gaseous feed stream in an amount in the range of from about 0.1 to about 10,000 µg/m³.

47. (withdrawn) A process as recited in claim 44 wherein said mercury is present in said gaseous product stream in an amount in the range of from about 1 to about 800 $\mu\text{g}/\text{m}^3$.

48. (withdrawn) A process as recited in claim 44 wherein said mercury is present in said gaseous product stream in an amount in the range of from about 3 to about 700 $\mu\text{g}/\text{m}^3$.

49. (withdrawn) A process as recited in claim 44 wherein said gaseous product stream contains less than about 80 weight % of the mercury contained in said gaseous feed stream.

50. (withdrawn) A process as recited in claim 44 wherein said gaseous product stream contains less than about 90 weight % of the mercury contained in said gaseous feed stream.

51. (withdrawn) A process as recited in claim 44 wherein said gaseous product stream contains less than about 95 weight % of the mercury contained in said gaseous feed stream.

52. (withdrawn) A process as recited in claim 35 wherein said gaseous product stream is contacted, in an adsorption zone, with an adsorbent selected from the group consisting of a zeolite, amorphous carbon, and combinations thereof.

53. (withdrawn) A process as recited in claim 52 wherein said composition oxidizes at least a portion of said heavy metal in said gaseous feed stream to an elevated oxidation state.

54. (withdrawn) A process as recited in claim 52 wherein said heavy metal is mercury and wherein said composition oxidizes at least a portion of said mercury in said gaseous feed stream from a zero oxidation state to a +1 or a +2 oxidation state.

55. (withdrawn) A process as recited in claim 52 wherein a treated gaseous product stream is withdrawn from said adsorption zone, and wherein said treated gaseous product

stream contains less than about 80 weight % of the heavy metal contained in the gaseous feed stream.

56. (withdrawn) A process as recited in claim 52 wherein a treated gaseous product stream is withdrawn from said adsorption zone, and wherein said treated gaseous product stream contains less than about 90 weight % of the heavy metal contained in the gaseous feed stream.

57. (withdrawn) A process as recited in claim 52 wherein a treated gaseous product stream is withdrawn from said adsorption zone, and wherein said treated gaseous product stream contains less than about 95 weight % of the heavy metal contained in the gaseous feed stream.

58. (withdrawn) A process comprising:

a) contacting, in a contacting zone, a gaseous feed stream comprising a heavy metal and oxygen with the composition of claim 14; and

b) withdrawing a gaseous product stream from said contacting zone.

59. (withdrawn) A process as recited in claim 58 wherein said gaseous product stream contains less heavy metal than said gaseous feed stream.

60. (withdrawn) A process as recited in claim 58 wherein said gaseous feed stream further comprises a compound selected from the group consisting of sulfur oxides, CO₂, water, nitrogen oxides, HCl, and combinations of any two or more thereof.

61. (withdrawn) A process as recited in claim 58 wherein said gaseous feed stream is a combustion gas.

62. (withdrawn) A process as recited in claim 58 wherein said gaseous feed stream is a stack gas derived from the combustion of coal.

63. (withdrawn) A process as recited in claim 58 wherein said contacting of step a) is carried out at a temperature in the range of from about 100 to about 325 °C.

64. (withdrawn) A process as recited in claim 58 wherein said contacting of step a) is carried out at a temperature in the range of from about 125 to about 275 °C.

65. (withdrawn) A process as recited in claim 58 wherein said contacting of step a) is carried out at a temperature in the range of from about 150 to about 225 °C.

66. (withdrawn) A process as recited in claim 58 wherein said heavy metal comprises a metal selected from the group consisting of arsenic, beryllium, lead, cadmium, chromium, nickel, zinc, mercury, barium, and combinations of any two or more thereof.

67. (withdrawn) A process as recited in claim 66 wherein said heavy metal is mercury.

68. (withdrawn) A process as recited in claim 67 wherein said composition converts at least a portion of said mercury in said gaseous feed stream from a zero oxidation state to a +1 or a +2 oxidation state.

69. (withdrawn) A process as recited in claim 67 wherein said mercury is present in said gaseous feed stream in an amount in the range of from about 0.1 to about 10,000 $\mu\text{g}/\text{m}^3$.

70. (withdrawn) A process as recited in claim 67 wherein said mercury is present in said gaseous product stream in an amount in the range of from about 1 to about 800 $\mu\text{g}/\text{m}^3$.

71. (withdrawn) A process as recited in claim 67 wherein said mercury is present in said gaseous product stream in an amount in the range of from about 3 to about 700 $\mu\text{g}/\text{m}^3$.

72. (withdrawn) A process as recited in claim 67 wherein said gaseous product stream contains less than about 80 weight % of the mercury contained in said gaseous feed stream.

73. (withdrawn) A process as recited in claim 67 wherein said gaseous product stream contains less than about 90 weight % of the mercury contained in said gaseous feed stream.

74. (withdrawn) A process as recited in claim 67 wherein said gaseous product stream contains less than about 95 weight % of the mercury contained in said gaseous feed stream.

75. (withdrawn) A process as recited in claim 58 wherein said gaseous product stream is contacted, in an adsorption zone, with an adsorbent selected from the group consisting of a zeolite, amorphous carbon, and combinations thereof.

76. (withdrawn) A process as recited in claim 75 wherein said composition oxidizes at least a portion of said heavy metal in said gaseous feed stream to an elevated oxidation state.

77. (withdrawn) A process as recited in claim 75 wherein said heavy metal is mercury and wherein said composition oxidizes at least a portion of said mercury in said gaseous feed stream from a zero oxidation state to a +1 or a +2 oxidation state.

78. (withdrawn) A process as recited in claim 75 wherein a treated gaseous product stream is withdrawn from said adsorption zone, and wherein said treated gaseous product stream contains less than about 80 weight % of the heavy metal contained in the gaseous feed stream.

79. (withdrawn) A process as recited in claim 75 wherein a treated gaseous product stream is withdrawn from said adsorption zone, and wherein said treated gaseous product stream contains less than about 90 weight % of the heavy metal contained in the gaseous feed stream.

80. (withdrawn) A process as recited in claim 75 wherein a treated gaseous product stream is withdrawn from said adsorption zone, and wherein said treated gaseous product stream contains less than about 95 weight % of the heavy metal contained in the gaseous feed stream.

81. (withdrawn) A process comprising:

- a) contacting, in a contacting zone, a gaseous feed stream comprising a heavy metal and oxygen with the composition of claim 17; and
- b) withdrawing a gaseous product stream from said contacting zone.

82. (withdrawn) A process as recited in claim 81 wherein said gaseous product stream contains less heavy metal than said gaseous feed stream.

83. (withdrawn) A process as recited in claim 81 wherein said gaseous feed stream further comprises a compound selected from the group consisting of sulfur oxides, CO₂, water, nitrogen oxides, HCl, and combinations of any two or more thereof.

84. (withdrawn) A process as recited in claim 81 wherein said gaseous feed stream is a combustion gas.

85. (withdrawn) A process as recited in claim 81 wherein said gaseous feed stream is a stack gas derived from the combustion of coal.

86. (withdrawn) A process as recited in claim 81 wherein said contacting of step a) is carried out at a temperature in the range of from about 100 to about 325 °C.

87. (withdrawn) A process as recited in claim 81 wherein said contacting of step a) is carried out at a temperature in the range of from about 100 to about 275 °C.

88. (withdrawn) A process as recited in claim 81 wherein said contacting of step a) is carried out at a temperature in the range of from about 125 to about 225 °C.

89. (withdrawn) A process as recited in claim 81 wherein said heavy metal comprises a metal selected from the group consisting of arsenic, beryllium, lead, cadmium, chromium, nickel, zinc, mercury, barium, and combinations of any two or more thereof.

90. (withdrawn) A process as recited in claim 89 wherein said heavy metal is mercury.

91. (withdrawn) A process as recited in claim 90 wherein said composition converts at least a portion of said mercury in said gaseous feed stream from a zero oxidation to a +1 or a +2 oxidation state.

92. (withdrawn) A process as recited in claim 90 wherein said mercury is present in said gaseous feed stream in an amount in the range of from about 0.1 to about 10,000 $\mu\text{g}/\text{m}^3$.

93. (withdrawn) A process as recited in claim 90 wherein said mercury is present in said gaseous product stream in an amount in the range of from about 1 to about 800 $\mu\text{g}/\text{m}^3$.

94. (withdrawn) A process as recited in claim 90 wherein said mercury is present in said gaseous product stream in an amount in the range of from about 3 to about 700 $\mu\text{g}/\text{m}^3$.

95. (withdrawn) A process as recited in claim 90 wherein said gaseous product stream contains less than about 80 weight % of the mercury contained in said gaseous feed stream.

96. (withdrawn) A process as recited in claim 90 wherein said gaseous product stream contains less than about 90 weight % of the mercury contained in said gaseous feed stream.

97. (withdrawn) A process as recited in claim 90 wherein said gaseous product stream contains less than about 95 weight % of the mercury contained in said gaseous feed stream.

98. (withdrawn) A process as recited in claim 81 wherein said gaseous product stream is contacted, in an adsorption zone, with an adsorbent selected from the group consisting of a zeolite, amorphous carbon, and combinations thereof.

99. (withdrawn) A process as recited in claim 98 wherein said composition oxidizes at least a portion of said heavy metal in said gaseous feed stream to an elevated oxidation state.

100. (withdrawn) A process as recited in claim 98 wherein said heavy metal is mercury and wherein said composition oxidizes at least a portion of said mercury in said gaseous feed stream from a zero oxidation state to a +1 or a +2 oxidation state.

101. (withdrawn) A process as recited in claim 98 wherein a treated gaseous product stream is withdrawn from said adsorption zone, and wherein said treated gaseous product stream contains less than about 80 weight % of the heavy metal contained in the gaseous feed stream.

102. (withdrawn) A process as recited in claim 98 wherein a treated gaseous product stream is withdrawn from said adsorption zone, and wherein said treated gaseous product stream contains less than about 90 weight % of the heavy metal contained in the gaseous feed stream.

103. (withdrawn) A process as recited in claim 98 wherein a treated gaseous product stream is withdrawn from said adsorption zone, and wherein said treated gaseous product stream contains less than about 95 weight % of the heavy metal contained in the gaseous feed stream.